The Impact of Weekly Math Tests and Strategy Instruction on Math Fluency

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The Impact of Weekly Math Tests and Strategy Instruction on Math Fluency

An Action Research Report by Anna Garnaas-Halvorson
The Impact of Weekly Math Tests and Strategy Instruction on Math Fluency

Submitted on May 23, 2014
In fulfillment of final requirements for the MAED degree
St. Catherine University
St. Paul, Minnesota

Advisor__________________________________________
Date____________________________________________
Abstract

A significant number of students enter the Elementary II years (Grades 4-6) without basic math fact fluency skills. This means teachers feel they need to revisit these skills and re-teach. This study tackles this concern by exploring the question of whether weekly math fact tests paired with teaching math strategies and individual goal-setting will have an effect on children’s ability to recall basic math facts accurately and efficiently. The study was performed in an Elementary I public Montessori classroom for grades one through three. The classroom community consisted of 25 students with varying strengths and abilities. Nine of the 25 students have Individual Education Plans or are in the process of Special Education referrals. The strategies were taught throughout the project and weekly fact tests were administered to students. I discovered that these two practices combined increased math fluency and confidence in my students.
Last year, I approached the Elementary II teachers at my school to inquire about an area of need for their incoming fourth grade students. I wanted my Action Research project to address a specific need and have a supportive effect on both students and teachers as children make the transition to the Elementary II classroom. All five Elementary II teachers concurred that children in fourth grade, on average, struggle enough with mental recall of math facts that they find themselves re-teaching these every year. This information supports the contention of Burns, M.K., Kanive, R., Nelson, P.M., & Ysseldyke, J.E. (2013), that only 32% of fourth grade students in the US are proficient in mathematics.

My uncle teaches middle and high school math in a St. Paul private school and says the problem still persists for those students who did not gain math fact automaticity in elementary school. This information also supports the contention of McCallum, E., Poncy, B.C., & Schmitt, A.J. (2010), that 38% of eighth grade students in the US are proficient in mathematics. I feel very strongly that memorizing math facts opens a new world of success for students in mathematics and for being successful in future math endeavors. McCallum et al contend that “fluency is a term used to describe fast and accurate academic responding” and that “fluent students tend to find complex math problems less frustrating and experience lower levels of math-related anxiety” (2010, p. 917). I wanted to focus on this area of abstraction with my first, second, and third grade students to better prepare them for upper level mathematics. Personally, math became more enjoyable when effort and time were no longer spent counting on my fingers or drawing pictures to find the answers. Confidence soars when the brain quickly recalls math facts fluently and with accuracy, as was made clear in the responses from the
student interviews. McCallum et al. suggests that students who can fluently complete math facts are better able to fluently compute subsequent advanced math tasks. Furthermore, a failure to achieve fluency affects a student’s willingness to attempt math tasks and creates a higher level of math-related anxiety (917).

A common theme in math fluency research is the stated fact that American children are not able to solve math facts as quickly or efficiently as children in other countries. Daly et al contends this is due to inadequate classroom opportunities for this type of practice (as cited in Burns et al, 2011). Many researchers gleaned this fact from National Mathematics Advisory Panel reports in recent years. Burns et al cites the NMAP of 2008 and says it “indicated that children in this country cannot solve single-digit addition, subtraction, multiplication, or division problems as quickly or efficiently as students from other countries.” Inefficient strategies for answering math facts, such as finger counting, negatively affect a child’s ability to apply math knowledge to more complex math concepts. The background research states that students need math fluency for independent living (Burns, M.K., Codding, R.S., & Lukito, G., 2011, p. 36) and those who lack fluency are at risk for math difficulties later in life (Burns et al, 2013, p. 660). When students can execute math skills quickly and with accuracy, their attention and energy can be allocated to more complex tasks for processing (Burns et al, 2011).

Researchers generally agree that children should master addition and subtraction facts by the end of first grade (Wubbena, Zane C., 2013). “Timed fluency tasks measuring accuracy and speed are quite indicative of skill mastery (Wubbena, Zane C., 2013, p. 153). Repetition in practicing math facts is also often missing from the classroom. “Repeated practice promotes accurate and quick responses to math stimuli and
increase understanding of related, more complex math tasks” (Duhon, G.J., Lee, S.B., Key, A., & Poncy, B., p. 77). Burns et al stress practice as of the utmost importance in math fluency, especially for children with learning disabilities. They suggest that even 70% of instructional time be used for such practice in the classroom. Testing children on math facts and practicing math facts are two separate entities. Each is an important component of building math fluency (Burns et al, 2011, p. 37).

Burns et al. maintain that students who are proficient should automatically retrieve arithmetic facts, and that poor computation fluency plays a fundamental role in math deficiencies. Students who lack fluency are at risk for math difficulties later in life, and those with automaticity are more likely to develop skills necessary for solving a wide variety of complex problems and interpreting abstract math principles. “Application of math facts to solve problems is one of the most fundamental goals for math education and is considered a distinct stage of understanding in cognitive models of learning” (Burns et al, 2013, p. 660). McCallum et al believe that math deficits are commonly found in all schools, and there are insufficient proven researched strategies available for teachers who want to fix the issue (p. 917). Further research is required in this area that appears to affect all schools.

I also focused attention on individual goal setting with a hope for increased motivation and decreased anxiety about classroom competition. “Since goal-setting is more individual, pupils experience more personal success, rather than stress from competition” (Madden, L.E., 1997, p. 413). Madden states that teachers found individual goal setting to benefit the learning process for students. Students were more willing to take risks in their learning. Their motivation improved, as did their self-pride. Because
they hold the power, it becomes a motivational force in their work. When they feel in control, they are more apt to work towards a self-decided goal (Madden, L.E., 1997, p. 413).

The research led me to a plan that would focus on the quick and accurate solving of math facts. McCallum et al states, “an instructional approach that directly emphasizes math fluency may be necessary (917).” Baker et al found that providing students and parents with direct feedback of student’s progress and success had positive impacts on their abilities in mathematics. I decided to focus energy and attention on teaching specific math strategies to help with the efficient automaticity of math facts. The focus of this research is three-fold; the weekly fact tests paired with teaching specific strategies, the individual goal setting of the students, and positive feedback for any and all successes.

The question considered is stated as follows: What impact will a mixture of focus on weekly fact tests with positive feedback, individual goal-setting, and direct strategy instruction have on children’s math fact fluency?

Description of Research & Methodology

The research on this topic supports my experience and ideas about math fact automaticity in elementary children. The biggest issue is the struggles experienced by children in mathematics when they have not memorized these facts. Not only will number and operation concepts be difficult and take a large amount of time, but more abstract concepts, such as finding common denominators using multiples, will be a strenuous process. The energy it takes to understand higher-level math concepts doesn’t often foster a desire for further challenge. Why not focus on giving children the ability to enjoy
mathematics at an early age? Memorized math facts will make math more enjoyable at higher levels.

The total number of students included in this study was 25. They spanned three grade levels, all between the ages of six and nine. There were ten first grade students, seven second grade students, and eight third grade students. All 25 students received permission to participate from parents or guardians. If a child was absent on any given fact test or strategy lesson day, they made up that work to keep the data consistent.

This is an eight month long Action Research project focusing on math fact fluency over all four operations. Students started with the addition test no matter their level of fluency. Each test consists of 100 facts, some being repeated commutatively throughout the test. There are two forms of each math test, so children are not necessarily given fact problems in the same order each week (Appendices A-H). To move from addition to subtraction, for example, a child must be able to answer all 100 math facts in five minutes or less with 100% accuracy. My goal is to have all third grade students show competency with at least the multiplication facts by the time they leave my classroom.

The third grade students who took memorization practice seriously last year are now thriving in mathematics in fourth grade. Their teachers have voiced their frustration because they still have to teach the remaining fourth grade students these math facts. I believe that if all teachers start in first grade, sincerely focusing on memorization by teaching strategies and implementing weekly fact tests, all students can have this instant recall through multiplication by fourth grade.

My students have participated in 19 weeks of Tuesday afternoon fact tests and memorization practice. In the permission letter home (Appendix I), I stated that by
signing this contract, the parent is also making a promise to practice math facts with their child on a regular basis. I gave several strategy ideas and examples of fun fact games families could play at home with their children. These were attached to the contract. My biggest disappointment during the process was the lack of practice being carried out at home, as I’ve learned through student surveys, interviews and general conversation. I can only control so much, but I continued to send home reminders with bits of research on the importance of this precious time used for setting a foundation in math for my students.

Each Tuesday afternoon following specialist time, the students enter the classroom, find a sharpened pencil with a good eraser, and sit at their tables. They are given the fact test based on their progress so far. The students came up with time completion goals according to their completion time the previous week. We start the timer and they go for it! The joy on their faces as they run their completed tests over to me is priceless.

Each week I recorded the children’s times and scores in a spreadsheet (Appendix N). I color-coded the data to help me see more clearly where each child was performing in this process. Pink was used for 100% accuracy and completion times of five minutes or less. Blue was used for children scoring between 90-99% and for times between 5:01-10:00. Blue scores were close to proficient and showed children who would soon move to the next operation. Orange was used for children who were struggling based on the parameters, with scores between 50-90% and times from 10:01-30:00. Red was used to show children who were struggling significantly and needed further support. Many children in the orange and red groups have specific challenges that help to explain their struggle. I also found the class average for each week in both time and accuracy, and then
the grade level average for both as well. Children who already passed out of an operation test were given a score of 100% in 5 minutes in the class average.

Observation was another tool utilized to determine the link between fluency and confidence in mathematics. The children who do well with challenge and love to race against a timer are obvious through observation. During the test each Tuesday, I jotted down observations about individual children and the class as a whole. The student survey (Appendix O) asked questions regarding the strategies used for solving math facts during the tests. Through observation, I was able to see which students continued to count using their fingers and which were automating their facts. The answers on the survey gave me a good idea of which strategies they perceived themselves to be using. The written observations also helped me understand the changes from week to week in the scores and abilities in the classroom. Many of the observations outlined personal struggles that may be affecting a given child that day. For example, “child #1 did not have breakfast this morning and is complaining of a stomach ache,” or “child #2 has been incredibly emotional all day and is not managing well. This may affect his ability to perform on the fact test today.” Many positive observations were made as well. “Child #3 told me this morning that he has been looking forward to this week’s test since last Tuesday. He is sure he will move on this week. What a great attitude!” and “child #4 stated this morning that she and her mom have been practicing her facts every day this past week in the car on the way home from school.” The observational comments help to explain why a score may be a large outlier on any given week.

Paired with the weekly tests were strategy lessons taught throughout the school year. I gave two identical lessons to each grade level on strategies for solving addition
and subtraction facts. All grades were given lessons (some were review from previous years) on addition strategies. The strategies were given in the following order: adding zero, one, two, and three, doubles of numbers, doubles +1, adding 10 and adding nine. The first strategy was taught using counting up. The children were asked to say the largest number first and count up the smaller. Doubles of numbers were practiced and memorized, leading naturally to doubles +1 (such as 6+7, 7+8, etc.).

Adding ten was quickly understood, in my opinion, because of the wealth of specific place value materials in the Montessori classroom and the children’s familiarity with these. They have a firm foundation in place value because of practice with these materials since Children’s House. Adding nine naturally followed, as the strategy is to add 10 and then subtract one from the answer. The subtraction strategy taught was to count up from the lower number to find the difference, thus making the transition from addition to subtraction facts even smoother. I led the second and third grade students to see even more patterns in multiplication facts using fact stars (Appendix J).

**Data Analysis**

Many things have surprised me during this process. My eyes have been opened to more focus issues than I was previously aware. I encountered children who were able to abstract new math concepts easily but continued to take 30 minutes or more on their fact test. Two students in particular are now in the process of evaluation for special education in focus areas. The project has also led to a couple Special Education referrals for students who need one on one support desperately because of focus and distraction challenges. The tests have provided data for much more, expanding the scope of the action research project.
There are also children who have newfound confidence and excitement about math and school in general because of their success with math facts. One child who has a hard time completing classroom work because of social tendencies has mentioned feeling a bit of a failure because of it. He surprisingly takes the fact tests very seriously. This child is one of only a few first grade students who I expect to complete fact memorization through multiplication this year. He struggled with math lessons in the fall, and now is excited whenever he is given a lesson with a new math concept.

The project has been a fun relationship builder. The children have been incredibly supportive of one another, as they often are in all areas, but this is a uniquely shared experience across all three grades. Connections have been formed between different aged students that may not have been without the shared experience. A third grade boy asked me if I could try taking all four fact tests in under five minutes with 100% accuracy. I said I would definitely try if he passed his subtraction test that day. He did, and it was a joy watching him correct my tests and see his eyes grow wide when I completed his challenge. This was a huge motivation for him to be able to do the same, and he is now on the division test.

I collected and analyzed data from several sources. Each week, data was collected from student fact tests (Appendices A-H). Their scores and times were entered into a spreadsheet (Appendix N). I then entered my written data into an Excel spreadsheet in order to create specific graphs outlining the data (See Figures 1-6). The average time and accuracy on addition fact tests for each grade level was found and entered into line graphs to show progress over time. The following graphs show the average growth over time on addition facts for individual grades. The M stands for mean or average.
Figures 1-2: The first grade group of ten students made gains in both accuracy and time. On average, the group decreased their time by 19 minutes and 43 seconds. Their average accuracy increased by 24.2%.
Figures 3-4: The second grade group of seven students made gains in both accuracy and time. On average, the group decreased their time by 32 minutes and 13 seconds. Their average accuracy increased by 11.57%.

Figures 5-6: The third grade group of eight students made gains in both accuracy and time. On average, the group decreased their time by nine minutes and 18 seconds. Their average accuracy increased by 21.5%.

I also wanted to show growth over time concerning both speed and accuracy, by comparing grade levels (see figures 7-8). I anticipated grade levels to progress at different speeds based on their age and experience with math facts. The following graph shows this data and the positive trends of growth, but at different rates. Observational data helps explain the dips and outliers that changed the trends of each graph.

Figure 7: The class as a whole averaged an accuracy increase of 19%.
Figure 8: The class as a whole decreased their time spent on 100 problems by an average of 17 minutes.

Another form of data collection was a student survey (Appendix O) administered three times throughout the project. The reason for the repetition was to show change in strategies, feelings, and amount of practice over time. The following shows the student responses to survey questions before, during, and at the end of the project. I was frustrated by the lack of practice at home and felt consistent practice outside of school.
would make for even further gains. However, the amount of students who grew from finger counting to using other strategies to complete automaticity was very positive. The research supports that this type of fluency will make easier transitions to more complex math problems. I want this kind of success for all my students, and the data shows growth in both confidence and enjoyment of math.

57.15% of children always used finger counting to answer facts according to the Pre-survey. 0% of children answered they always use finger counting according to the Post-survey. 48% of children continue to use the finger counting strategy sometimes. According to answers in the student interviews, students chose finger counting as their go-to strategy for math facts they had not yet memorized.

The following table outlines the student’s feelings regarding answers on the survey. They were asked to take the same survey three times, once in September, again in December, and once again in March. Table 1 outlines the most valid questions and the percentage of growth in each area over the course of study. These are the areas research shows are most beneficial for math fluency development.

<table>
<thead>
<tr>
<th>Survey Question</th>
<th>Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I can answer math facts quickly.</td>
<td>+38.5%</td>
</tr>
<tr>
<td>2. I study math facts at home.</td>
<td>+15.3%</td>
</tr>
<tr>
<td>3. I count on my fingers to solve math facts.</td>
<td>-57.15%</td>
</tr>
<tr>
<td>5. I use mental math to recall math facts.</td>
<td>+32.19%</td>
</tr>
<tr>
<td>8. I feel good about my math facts.</td>
<td>+36%</td>
</tr>
</tbody>
</table>

Table 1
Each vital area of fact memorization showed improvement, with a large percentage of children moving away from counting facts on their fingers and using mental math to recall facts accurately. The data gleaned from the Student Survey showed promising growth in all areas. Their responses indicate use of strategies and decrease of finger counting over time. I am most pleased by the percentage of children who now feel they are able to use mental math when solving math facts. This is a great indicator of math fluency.

I also conducted Student Interviews (Appendix M) to determine the children’s feelings of success or lack of success after 20 weeks of this process. I chose one child from each grade level randomly and asked them the same four questions. I asked each child how they felt about answering math fact problems before we started the fact tests, how they feel now, whether working on math facts is helping in other class work, and whether they advise continuing this work with future classes. Their responses were overwhelmingly positive. All three students stated they felt more confident and that math is much easier now than it was before the fact tests. They felt that memorizing the facts made them more excited about math because it wasn’t as hard. They all agreed that future classes would benefit from the project as well.

The order of operations tested was as follows: addition, subtraction, multiplication, and division. To move from one operation to the next, students were required to answer all 100 fact problems in five minutes or less with 100% accuracy. This is a high standard, especially for the six year old students, but one I feel is necessary to be fluent in one operation. When a child is truly automating their facts, meaning the answer is recalled quickly without much effort, they are able to complete their tests within the
given parameters. There is a chart hanging in our classroom with the students’ names
down a column and the operations listed across the top. Every time a student passes a
given fact test, a sticker is placed on their chart. This excited the children and they made
sure to give a reminder if I hadn’t yet placed a sticker in the appropriate column. The
progress across operations is shown (see Chart 1), keeping in mind students working on
division facts have mastered the previous three operations:

![Chart 1]

The fact that more than half of my class has mastered one or more operations in
the past seven months is very promising. Starting this work with first grade students each
year will give them three years to have automated their math facts through multiplication.
Based on the progress this year, this will be an outcome I can expect from most of my
students in the years to come. This was my greatest hope for the children’s future success
in mathematics and to help transition their progress into the Elementary II years, where
teachers feel so frustrated by the lack of math fluency of incoming fourth grade students.
The final group of data collected was a summative survey sent home to parents to determine areas they felt had improved for their children in math automaticity over the school year. Table 2 outlines the responses of these parents.

<table>
<thead>
<tr>
<th>Question</th>
<th>Never</th>
<th>Sometimes</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer facts quickly</td>
<td>0%</td>
<td>71.4%</td>
<td>28.6%</td>
</tr>
<tr>
<td>Practices at home</td>
<td>0%</td>
<td>71.4%</td>
<td>28.6%</td>
</tr>
<tr>
<td>Daily practice time</td>
<td>14.3%</td>
<td>57.1%</td>
<td>28.6%</td>
</tr>
<tr>
<td>Finger Counting</td>
<td>21.4%</td>
<td>78.6%</td>
<td>0%</td>
</tr>
<tr>
<td>Confidence</td>
<td>0%</td>
<td>64.3%</td>
<td>35.7%</td>
</tr>
</tbody>
</table>

The responses to the parents interview paralleled the responses on the parent survey. Most parents became excited at the idea of a math fact practice log to go home nightly. Parents also mentioned interest in sharing ideas across classroom families to better implement effective practice at home. They were overwhelmingly pleased with the growth in their child’s confidence across math subjects.

**Action Plan**

Administering weekly fact tests and incorporating fact strategy teaching into lessons was a tangible way to reach the desired result. I did not anticipate the impact to be so great for a seemingly simple addition to classroom instruction. The difference between the children’s baseline ability and the ability measured following strategy instruction and weekly fact tests were great. We visualized success as a group by orally stating goals and achievements in front of our peers, causing them to hold each other more accountable.
The difficulty with this methodology was obvious for children whose greatest challenge was maintaining focus. Their ability and confidence in math grew, as was apparent in both the interviews and student survey. However, these specific children showed little to no growth in fluency on the written 100 fact tests. This form of assessment was not showing growth that paralleled actual academic growth in fact fluency for these students. Many children are able to recall facts through multiplication when asked orally with little use of their fingers, but were unable to focus long enough to answer all 100 problems without large amounts of stress. One child finished fact tests at home each week with his family, who read the problems while the child moved around the room and answered facts orally. Gains were seen in speed and fluency in this way, but testing all children who struggle with attention in this way was not realistic. We lacked the manpower and resources to do so. Also, not all parents have the time or the means to spend this time and energy at home testing their child each week.

To continue implementation of this project, there must be some type of modifications for those students who struggled the most in this way. Their scores fluctuated so greatly in terms of time taken to complete fact tests that their scores skewed the data. I plan to give these students a shortened version of the fact test in the future. They will be required to answer with the same accuracy in a shortened amount of time. I hope this will ensure greater success for these children. When shown only a few problems at a time, these children seemed to complete the test in less time. Specific students did not show true results because their struggle to attend made it very difficult to complete 100 math problems in one sitting. I recommend that other researchers consider administering tests with fewer problems to those students that struggle in this way. They
MATH FACT FLUENCY

may then have parameters of 100% in 2 minutes 30 seconds on 50 fact problems. This is something I will change next year for specific students who struggle with focus and attention.

I would recommend conducting this project if the researcher has ample time to do so, preferably the entire school year. The progress was consistent, but ending such work would impede a child’s ability to become fluent with their math facts. I believe the reason this study was so successful was the consistent implementation over a long period of time. I would also recommend further research into games or memorization strategies that specifically help children with focus difficulties.

I recommend continuation of individual goal setting for fact tests. I would also consider using more instruction time for practice of math facts in the classroom. It seemed families struggled to find ample time to practice facts at home. Also, a more structured request for at home practice may be beneficial. Next year, I will require this practice as a part of weekly homework, with a practice log similar to the one we use for recording reading each night. This may be a helpful reminder for family members to support students in their fact fluency at home. The parent survey also supports this idea for future parent involvement in fact fluency success. Next year I will also send home weekly ideas with a space for comments from families to keep communication more consistent. I believe this will help our classroom community support each other in finding helpful games, websites, strategies, etc. and be able to share these with the entire class.

Even though we encountered bumps and struggles along the way, in the end, every student improved in math fact fluency, and more importantly, confidence and excitement about math in general. The students were able to support and hold each other
accountable because they had a shared goal and were open with the group about their struggles and successes. The pride they showed for classmate successes was beautiful and touching. I believe something that started as a basic hope for higher math fluency, became not only that but also fostered a deeper connection for an already close classroom community. The kids really owned this process and exhibited such maturity and improved confidence in doing so.
References


McCallum, E., Poncy, B.C., & Schmitt, A.J. (2010). Comparison of behavioral and
constructivist interventions for increasing math-fact fluency in a second-grade classroom. *Psychology in the Schools*, 47(9), 917-930.


Appendix A
Addition Fact Test Form 1

Five Minute Addition Test - Form 1

Name ___________________________ Date ________________________

3 1 4 6 0 7 5 8 8 6
+ 4 + 2 + 5 + 2 + 3 + 2 + 1 + 8 + 2 + 0

5 0 6 0 6 2 4 0 7 5
+ 9 + 7 + 7 + 4 + 9 + 3 + 4 + 0 + 1 + 0

0 8 5 0 2 8 8 6 6 1
+ 8 + 0 + 4 + 6 + 5 + 1 + 4 + 6 + 1 + 3

0 7 9 3 2 3 0 3 0 4
+ 1 + 6 + 4 + 9 + 8 + 7 + 5 + 3 + 2 + 7

5 9 2 1 4 3 4 7 9 9
+ 2 + 9 + 0 + 1 + 8 + 6 + 3 + 4 + 7 + 0

9 4 5 9 6 1 8 3 4 5
+ 2 + 9 + 8 + 5 + 8 + 0 + 6 + 0 + 0 + 3

2 7 9 9 2 3 1 2 1 5
+ 2 + 7 + 6 + 1 + 9 + 1 + 4 + 7 + 6 + 5

7 6 2 7 8 1 8 4 1 4
+ 3 + 5 + 6 + 5 + 7 + 8 + 0 + 6 + 9 + 2

5 6 2 1 9 5 3 8 9
+ 6 + 4 + 1 + 8 + 5 + 8 + 7 + 2 + 5 + 3

8 7 2 1 7 6 4 3 0 3
+ 3 + 0 + 4 + 7 + 9 + 3 + 1 + 5 + 9 + 8

© The Center for Comprehension: Minnesota Programs 612-246-2096
Five Minute Addition Test - Form 2

Name __________________________ Date ______________________

\[
\begin{array}{cccccccccccc}
8 & 7 & 2 & 1 & 7 & 6 & 4 & 3 & 0 & 3 \\
+ 3 & + 9 & + 4 & + 7 & + 0 & + 3 & + 1 & + 5 & + 9 & + 8 \\
\hline
5 & 6 & 6 & 0 & 0 & 2 & 4 & 0 & 7 & 5 \\
+ 9 & + 9 & + 7 & + 4 & + 7 & + 3 & + 4 & + 0 & + 1 & + 0 \\
\hline
7 & 8 & 2 & 7 & 6 & 1 & 8 & 4 & 1 & 4 \\
+ 3 & + 7 & + 6 & + 5 & + 8 & + 0 & + 6 & + 9 & + 2 \\
\hline
0 & 2 & 9 & 3 & 7 & 3 & 0 & 3 & 9 & 4 \\
+ 1 & + 8 & + 4 & + 9 & + 6 & + 7 & + 5 & + 3 & + 0 & + 7 \\
\hline
5 & 4 & 2 & 1 & 9 & 3 & 4 & 7 & 9 & 0 \\
+ 2 & + 8 & + 0 & + 1 & + 9 & + 6 & + 3 & + 4 & + 7 & + 2 \\
\hline
9 & 6 & 5 & 9 & 4 & 1 & 8 & 3 & 4 & 5 \\
+ 2 & + 8 & + 8 & + 5 & + 9 & + 0 & + 6 & + 0 & + 0 & + 3 \\
\hline
2 & 2 & 9 & 9 & 7 & 3 & 1 & 2 & 1 & 5 \\
+ 2 & + 9 & + 6 & + 1 & + 7 & + 1 & + 4 & + 7 & + 6 & + 5 \\
\hline
0 & 2 & 5 & 0 & 8 & 8 & 8 & 6 & 6 & 1 \\
+ 8 & + 5 & + 4 & + 6 & + 9 & + 1 & + 4 & + 6 & + 1 & + 3 \\
\hline
5 & 1 & 2 & 7 & 6 & 9 & 5 & 3 & 8 & 9 \\
+ 6 & + 5 & + 1 & + 8 & + 4 & + 8 & + 7 & + 2 & + 5 & + 3 \\
\hline
3 & 0 & 4 & 6 & 1 & 7 & 5 & 8 & 8 & 6 \\
+ 4 & + 3 & + 5 & + 2 & + 2 & + 1 & + 8 & + 2 & + 0 \\
\end{array}
\]
# Five Minute Subtraction Test - Form 1

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<thead>
<tr>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

```
8  
- 8  
3  
- 0  
1  
- 3  
11 
- 4  
5  
- 3  
17 
- 7  
13 
- 5  
9  
- 8  
12 
- 1  
9  
- 6  
13 
- 1  
8  
- 9  
10 
- 2  
7  
- 1  
6  
- 2  
10 
- 1  
6  
- 3  
14 
- 9  
15 
- 5  
5  
- 5  
9  
- 1  
6  
- 6  
16 
- 9  
11  
- 3  
8  
- 2  
5  
- 8  
2  
- 1  
10 
- 1  
8  
- 7  
6  
- 5  
9  
- 1  
5  
- 3  
4  
- 4  
5  
- 1  
13  
- 8  
16  
- 4  
7  
- 7  
15 
- 5  
10  
- 2  
4  
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### Five Minute Subtraction Test - Form 2

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Appendix E
Multiplication Fact Test 1

Five Minute Multiplication Test - Form 1

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Appendix G
Division Fact Test Form 1

Five Minute Division Test - Form 1

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Appendix H
Division Fact Test Form 2

Five Minute Division Test - Form 2

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Appendix I
Permission Letter

September 26, 2013

Dear Parents and Families,

Hello! This is Ms. Garnaas and I am writing to inform you about my Action Research project this year. In order to complete my MA in Education at St. Catherine University, I am currently working on an Action Research project to carry out in the classroom this fall.

Action Research involves looking closely at a teaching technique or product and examining its effectiveness. I will be taking a closer look at math fact memorization, techniques to foster this memorization, and effectiveness of different teaching strategies and weekly math fact tests. Your children have taken one addition fact test already this week. Attached are your child’s results, their time, number correct, and personal goal for next week.

Memorizing math facts may seem like a trivial, time-consuming feat. On the contrary, there is no better way to set your child up for success in future mathematics. The time they spend counting given problems on their fingers is taking away from valuable, deep thinking and focused work time. I am so excited for your children to be experts in math facts. Their ability to abstract new mathematical concepts will soar. I have done extensive research on this subject and am very motivated to make this happen this school year and in the future!

We begin with addition facts and teach different tricks for memorization: ways to make ten, doubles of numbers, doubles plus 1, and so on. Once a child is able to complete the 100 facts in 5 minutes with 100% accuracy they will move on to subtraction, multiplication, and division facts. For some children, 5 minutes will not be achieved this year, and that’s OK! We will all do our best and work very hard to achieve our goals.

This endeavor won’t be possible without your support at home. By signing this form, you are agreeing not only to allow your child to participate in this study, but also to create a space in your family schedule to practice math facts with your child. Dollar stores sell flash cards for a very low price. I will also make and laminate flash cards for anyone who requests them.

Please remind your child that, like with any other skill, memorizing these facts will take practice. No one is born having his or her math facts memorized! I can only play the piano and paint because I have repeatedly practiced these skills for years. The playing field is even because this skill will require work for all the children.

When I present this project to the college, no names, photographs, or any other type of personal information will be shared.
MATH FACT FLUENCY

Go for it!
Sincerely,
Anna Garnaas

(Please return this form to me with your child’s homework next week!)
Student’s name
Parent’s Signature

I give permission for my child to be included in this action research project.
Yes______________________ No______________________

Your child, ____________________________, was able to complete 100 + math facts in
________________________________minutes with ___________________________ accuracy.

Your child’s goal for next week is to finish their + fact test in
_______________________ minutes.

Ideas for practicing facts:

**Flash cards** - try to stay away from counting on your fingers or with objects. Quick recall is the goal!

**Subtraction Salute**
What they’ll practice: Addition, subtraction
What they’ll need: One deck of cards for every three students (face cards are worth 11)
How to play: Two players are the “soldiers” and one player is the “general.” Deal half a deck to each soldier. To begin the game, both soldiers salute the general by holding one of their cards up to their forehead (they can’t see the card they’re holding but the other two players can).
The general (the only one who can see both cards) adds the two numbers together and says the sum aloud. Each soldier then takes that sum, subtracts the number her opponent is holding, and calls out the value of the card she can’t see. Whoever calls out the correct number first gets to keep both cards. Play ends when time runs out or someone wins all the cards.

**Double Down**
What they’ll practice: Adding doubles
What they’ll need: Two dice, one piece of paper, and one pencil per student
How to play: In pairs, time students so that each round of play lasts five minutes. When you say, “Roll ’em!” everyone rolls their two dice simultaneously. Anytime someone rolls doubles, they say, “Double Down!” Both students in that pair should stop rolling, then add the value of the dice, and record the sum under the player’s name that rolled it.
As play continues, students keep track of both sets of scores. Whoever has the most points at the end of five minutes wins.

Slam Ten
**What they’ll practice:** Adding multiples of 10  
**What they’ll need:** One deck of cards per pair  
**How to play:** Remove face cards and deal each player half the remaining cards. Taking turns, players flip cards face up one by one. When the first card is revealed, both players multiply the number shown by 10 and say the value out loud. For instance, if one flips over a three of clubs, both say, “Thirty.” Players keep flipping cards one at a time, always adding the value times 10 and saying it aloud. For example, if the next card were a four of hearts, they’d both say, “Seventy,” because 30 plus 40 is 70. Whenever the total value of the cards lands on 50, 100, 150, etc., either player may “slam” the deck with his hand. The fastest slammer keeps all the cards. When time is up, each player counts the value of her cards in 10s (not the number of cards!) to determine a winner.

**Counting up and counting back**  
For the addition facts, I tell the kids to "think the biggest number first and add up." Think "9" and count on 7 more for 7 + 9. For the subtraction facts, if there is a big number on the bottom, ex. 11 - 8, think 8 and count up to 11. Little number on the bottom, ex. 11 - 3, think 11 and count back 3.
Appendix J
Multiplication Fact Stars
Appendix K
Parent Survey

Date ________________________
Name_______________________

Hello! Thank you for supporting your child in their attempts to memorize their math facts. Below is a quick survey that will help when planning future implementation of math instruction in our classroom. Please answer as honestly as you can, as I will be better able to improve my teaching this way.

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<td>Your child can answer math facts quickly.</td>
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<td>Your child practices math facts at home.</td>
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<td>You set aside time each day for this practice.</td>
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<td>Your child counts math facts on their fingers.</td>
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<td>Your child feels confident about their math facts.</td>
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2 More Questions

1. Would a nightly math fact practice log (like the Reading Record) be a helpful tool in remembering and carrying out nightly fact practice at home with your child?
   A lot! A little Not at all

2. Do you feel your child has improved in their recall (quick ability to answer math facts accurately) this year?
   A lot! A little Not at all

Any further comments: ____________________________________________________
Appendix L
Parent Interview

Question 1
*Do you believe it is important to memorize math facts? Why or why not?*

Parent #1: Yes, because if you know your math facts, like your simple math facts, then you can spend more time learning more complicated math problems. The simple math facts are something you’re actually going to use for the rest of your life.

Parent #2: Yes, so that you have the basics, so you can build from those basics without having to think about them very much. Yes. To be able to move on to more interesting/challenging math, need to not be spending time on simple, memorizable calculations. Also, instant recall on basic math facts increases confidence of your math skills/intelligence/ability.

Parent #3: Yes - because it makes it so much easier over time to solve math problems. It is also good for the brain to have to memorize and store knowledge.

Question 2
*What do you feel is the most challenging part of memorizing math facts for your child?*

Parent #1: The repetition, like remembering to do it at night above and beyond his regular homework and other things we have to do. Getting him to care about doing it. What I started doing that’s worked well is I take a deck of cards and give him a number like 17, then the whole deck of cards we take 17 and subtract any card he chooses. It’s more of a game and he enjoys it more because he doesn’t have to write it down.

Parent #2: Just motivating, consistent practice. Making time for it. Orienting to it as fun rather than a chore.

Parent #3: Having enough time to do it. And remember to do it. If it is not a part of everyday task it is challenge to fit it in. I’d like the idea of having it be a part of an every day task like the reading log. Also feel challenged by lack of my own patience. It is hard to ask the same fact questions over and over and then it takes a REALLY long time to find the answer. Especially since she often starts counting from the beginning. If the problem is 9 + 6, she will start counting to 9 first then add six. We are working on this but it is a bump in the road. Would also love to have more variety and ideas for being creative and making it fun and playful.

Question 3
*Describe this experience of fact memorization work for your child?*

Parent #1: It was challenging at first, like trying to figure out what would get him to want to do it more, but once we figured out to make it more of a game it made it easier. The hardest part was just remembering to do it.
Parent #2: His grandmother established a regular routine of drilling him on multiplication tables twice a week when he went to her house after school. With a carrot (screen-time after math drills completed). And that seemed to work very well.

Parent #3: I do not understand the question.

Question 4
Do you enjoy math? Describe your own math education experience. Were you expected to memorize math facts at a young age?

Parent #1: I was never a big fan of math. It wasn’t a strong suit for me. I remember specifically in fourth grade learning the multiplication tables. I think if someone had made it more fun, I would have enjoyed it more. I’m a visual learner and so just doing stuff like math on paper wasn’t as interesting to me, but geometry was interesting.

Parent #2: Yes and yes. Loved math as a kid, was good at it and enjoyed challenges. Expected to memorize basic math facts at early age.

Parent #3: Yes, I enjoy math very much and yes I had to memorize math facts as well. I actually enjoyed it quite a bit. I was a strong math student up until late HS but it wasn’t my main interest. I do remember the joy of getting the right answers! And the pride that came with it. I especially enjoyed the process of finding solutions and the different routes you could take to get to the same answer. But I also enjoyed the rigid rules and specific guide lines...what needs to happen first...then....

Question 5
Are you willing to spend 5-10 minutes each day practicing these with your child next year, whether in the car, in bed, while playing outside, at the dinner table, etc.? Does that sound like a feasible thing for your family?

Parent #1: Yes, it’s feasible and I would do it. I just have a hard time remembering to do it.

Parent #2: Yes, it does.

Parent #3: It does, but it goes back to the challenge of finding the time - I’d love to have our families share ideas for different ways they incorporate this into their own daily schedules.
Appendix M
Student Interview

Question 1

How did you feel about answering math facts before we started this project?

Student #1: I felt bad at it, like plus I was pretty good at, but the other ones I couldn’t snap and say, “That’s it!”

Student #2: Answering math facts used to make me feel nervous and in first grade I would count on my fingers.

Student #3: I sort of felt bad at them. I would have just guessed or counted it on my fingers. I liked them still, but it was harder.

Question 2

How do you feel about answering math facts now that it’s been a focus for our class?

Student #1: It really helps. It’s just a lot easier to get it right away in my head.

Student #2: Now I only use my fingers for one fact in a row or for none in the row. It’s helped doing all the practice. I still feel a little bit nervous but I feel different being on subtraction also. I feel good that I was able to move on to a new test.

Student #3: I feel like, really good now because I got better and now I can go faster and it’s more easier. Like 9 + 6 I still need to count on my fingers, but all the ones, twos, 8 + 9 and 6 + 5, I know them right away.

Question 3

Has working on memorizing your math facts helped you in your other work?

Student #1: The math work is easier since I memorized my math facts. It’s easier to do because I just know 7 x 3 is 21 and that’s part of math facts.
Student #2: Sometimes for math on the board I have to write it down but usually I don’t use my fingers anymore. For some that you could lose track of I usually write it down on paper, other times I can do the word problems automatically in my head now. If it’s a math work, then it has helped me because usually I don’t have to use my fingers anymore and that makes it a lot quicker and easier.

Student #3: Yes, it’s helped with the rest of math because I just know them right away and I like math better because I get excited because it’s really fun because it’s easier. And now I’m on subtraction. It’s hard but fun. Like in math dice, it says, “Think fun!” I feel really…what am I trying to say? I feel confident.

**Question 4**

*Would you recommend I continue this work with students in years to come?*

Student #1: Yes, it’s beneficial and definitely helps. Keep doing it in years to come.

Student #2: Yes, because then they can be really quick at their math because then they can answer their math facts really quickly if someone asks them what it is when they’re older.

Student #3: I think you should keep doing it because it’s really fun and it makes me feel good.
Appendix N
Data Spreadsheet
Appendix O
Student Survey

Name____________________________     Date________________________

Please answer the following questions as honestly as you can. Think about strategies that help you when completing the fact tests at school, classroom math assignments, homework, and practicing facts at home. Check the box that is the most true for your math fact experience. If you do not understand a question, please ask an older student or the teacher to explain it to you. Thank you!:

<table>
<thead>
<tr>
<th>Question</th>
<th>Never</th>
<th>Sometimes</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can answer math facts quickly.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>I study math facts at home.</td>
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<tr>
<td>I count on my fingers to solve math facts.</td>
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<tr>
<td>I use pictures or tally marks to help solve math facts.</td>
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<tr>
<td>I use mental math to recall math facts.</td>
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<td></td>
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<tr>
<td>I guess at the answer and don’t really think about it.</td>
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<td></td>
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<tr>
<td>I enjoy answering math facts.</td>
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<tr>
<td>I feel good about my math facts.</td>
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